CLAIMS

1. A tandem linear ion trap and time-of-flight mass spectrometer, the ion trap having a straight central axis orthogonal to the flight path of said time-of-flight mass spectrometer and comprising;
a set of electrodes, at least one said electrode having a slit for ejecting ions towards said time-of flight mass spectrometer;
a set of DC voltage supplies to provide discrete DC levels and a number of fast electronic switches capable of connecting and disconnecting said DC supplies to at least two said electrodes of said ion trap;
a neutral gas filling the volume of said ion trap in order to reduce the kinetic energy of trapped ions towards equilibrium;
a digital controller to provide a switching procedure for ion trapping, manipulations with ions, cooling and including one state at which all ions are ejected from said ion trap towards said time-of-flight mass spectrometer.

2. A tandem linear ion trap and time-of-flight mass spectrometer according to claim 1, wherein said set of electrodes comprises 4 elongated electrodes arranged symmetrically with respect to each other, and arranged to be parallel with respect to an ion trap axis.

3. A tandem linear ion trap and time-of-flight mass spectrometer according to claim 2, wherein said at least one electrode having a slit for ejecting ions has a surface of substantially hyperbolic shape with the centre of said slit positioned symmetrically with respect to the apex of said hyperbola.

4. A tandem linear ion trap and time-of-flight mass spectrometer according to claim 1 wherein said neutral gas has a molecular mass smaller than the mass of ions of interest and said ion trap is filled with said neutral gas to a pressure in the range from 0.01mTorr to 1mTorr.

5. A tandem linear ion trap and time-of-flight mass spectrometer according to claim 1, wherein said digital controller includes a digital processor capable of

calculating an arbitrary switching sequence and control means to control a set of said number of said fast electronic switches according to said arbitrary switching sequence.

6. A tandem linear ion trap and time-of-flight mass spectrometer according to claim 1, wherein said switching procedure includes a final step during which the voltages on said electrodes of said ion trap are periodically switched between a set of states and after a time sufficient for ion cooling the voltages on said electrodes of said ion trap are switched to a final said state for ejection of said ions from said ion trap.

7. A tandem linear ion trap and time-of-flight mass spectrometer according to any preceding claim further including a pulsar, said time-of-flight mass spectrometer having a flight path positioned orthogonally to the plane of said ejected ions.

8. A tandem linear ion trap and time-of-flight mass spectrometer according to claim 7, wherein said pulsar is composed of two parallel plate electrodes, one of which is a semi-transparent mesh, each said parallel plate positioned parallel to the plane of said ejected ions.

9. A tandem linear ion trap and time-of-flight mass spectrometer according to claim 7, wherein said pulsar is connected to a high voltage supply by a set of fast electronic switches that are controlled by a controller.

10. A tandem linear ion trap and time-of-flight mass spectrometer according to any of claims 1 to 6 wherein the flight path of said time-of-flight mass spectrometer is positioned inline with the ejection path of ions.

11. A tandem linear ion trap and time-of-flight mass spectrometer as claimed in any of claims 1 to 6 or claim 10, wherein an opposite pair of electrodes (Y pair) of said set of electrodes is connected to a first subset of said number of said fast electronic switches capable of switching at a repetition rate, and at least one of another oppositely positioned pair of electrodes (X pair) of said

set of electrodes is connected to a second subset of said number of said fast electronic switches which has a higher voltage rating, said second subset of fast electronic switches connects said DC voltage supply to said X electrodes for ejection of said ions.

12. A tandem linear ion trap and time-of-flight mass spectrometer as claimed in claim 11, wherein said first subset of said number of said fast electronic switches includes 2 serially linked high repetition switches, switching between a positive and negative voltage to provide said Y pair of electrodes of said set of electrodes with a rectangular waveform.

13. A tandem linear ion trap and time-of-flight mass spectrometer as claimed in claim 11, wherein the value of the voltage provided to said electrodes is above 4 kV or below –4kV.

14. A method of extracting ions from a linear ion trap, said ion trap being driven by a set of digital switches, said method comprising the following steps;
trapping said ions in said ion trap by switching between a set of trapping states defined by a set of voltage states on the electrodes of said ion trap;
cooling said trapped ions by collisions with a buffer gas down to equilibrium:
and switching from a pre-selected trapping state to a final ejection state in a pre-selected time.

15. A method of extracting ions from a linear ion trap as claimed in claim 14, where said set of trapping states consists of two states, each of said states lasts for half of a set period.

16. A method of extracting ions from a linear ion trap as claimed in claim 14, wherein said buffer gas fills said ion trap at pressures in the range from 0.01mTorr to 1mTorr.

17. A method of extracting ions from a linear ion trap as claimed in claim 15, wherein said set period is in the range from 0.3 micro seconds to 1.0 micro seconds.

18. A method of extracting ions from a linear ion trap as claimed in claim 14, where the final trapping state prior to said ejection state has a duration of approximately one quarter of a set period.

19. A tandem linear ion trap and time-of-flight mass spectrometer substantially as herein described with reference to figures 1, and 4 to 18 of the accompanying drawings.

20. A method of extracting ions from a linear ion trap substantially as herein described with reference to figures 1, 4 to 18 of the accompanying drawings.